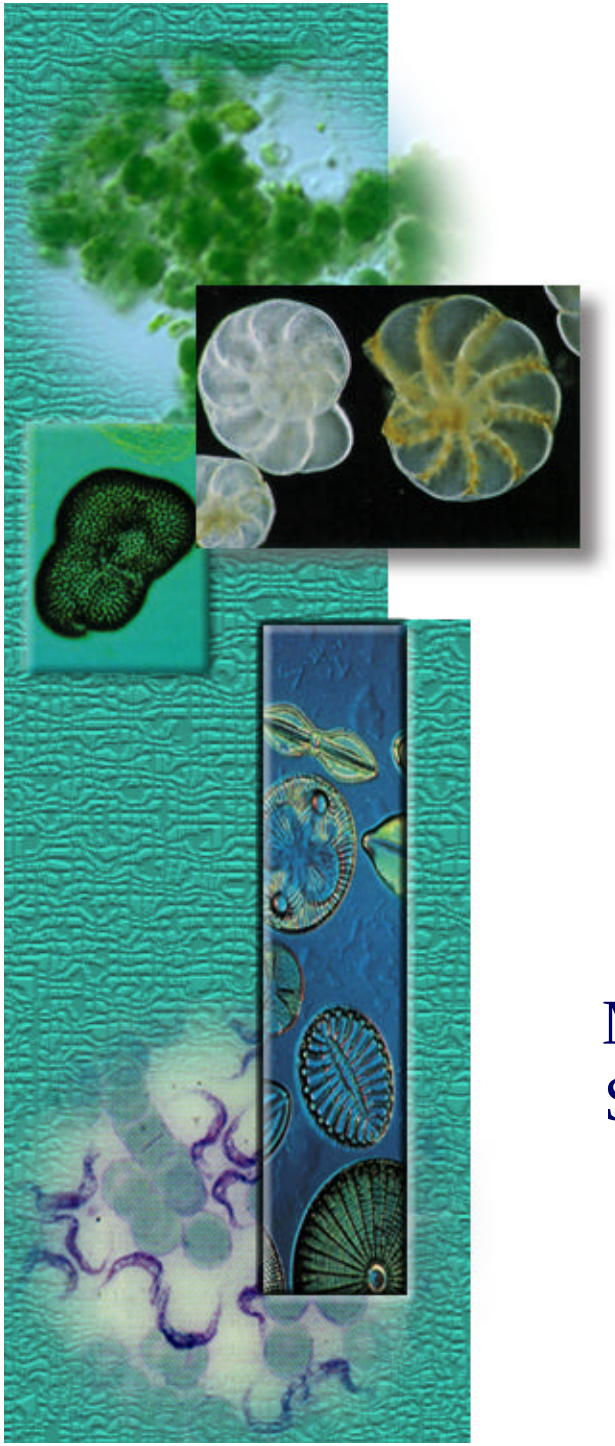


Astrobiology

Presented by

Michael Meyer, *NASA Hq Discipline Program Scientist*
Scott Hubbard, *Interim Manager–Astrobiology Institute*

Outline

- Astrobiology Overview
- Astrobiology Roadmap
- NASA Astrobiology Institute Status
- NASA Astrobiology Research Laboratory
- Astrobiology Advanced Mission & Technology Status
- Education & Public Outreach
- 3 Messages/Summary
- URL's

Astrobiology

The study of life in the Universe, focused on three fundamental questions:

- How does life begin and evolve?
- Does life exist elsewhere in the Universe?
- What is the future for life on Earth and beyond?

Astrobiology Elements

Grants Programs

- Exobiology
  - Research centered on pathways leading to and from the origin of life, to determine the potential for life elsewhere in the Universe
- Evolutionary Biology
  - New research program to understand the physical and biological forces that affect biological evolution and the interaction of life with its environment

NASA Astrobiology Institute (NAI)

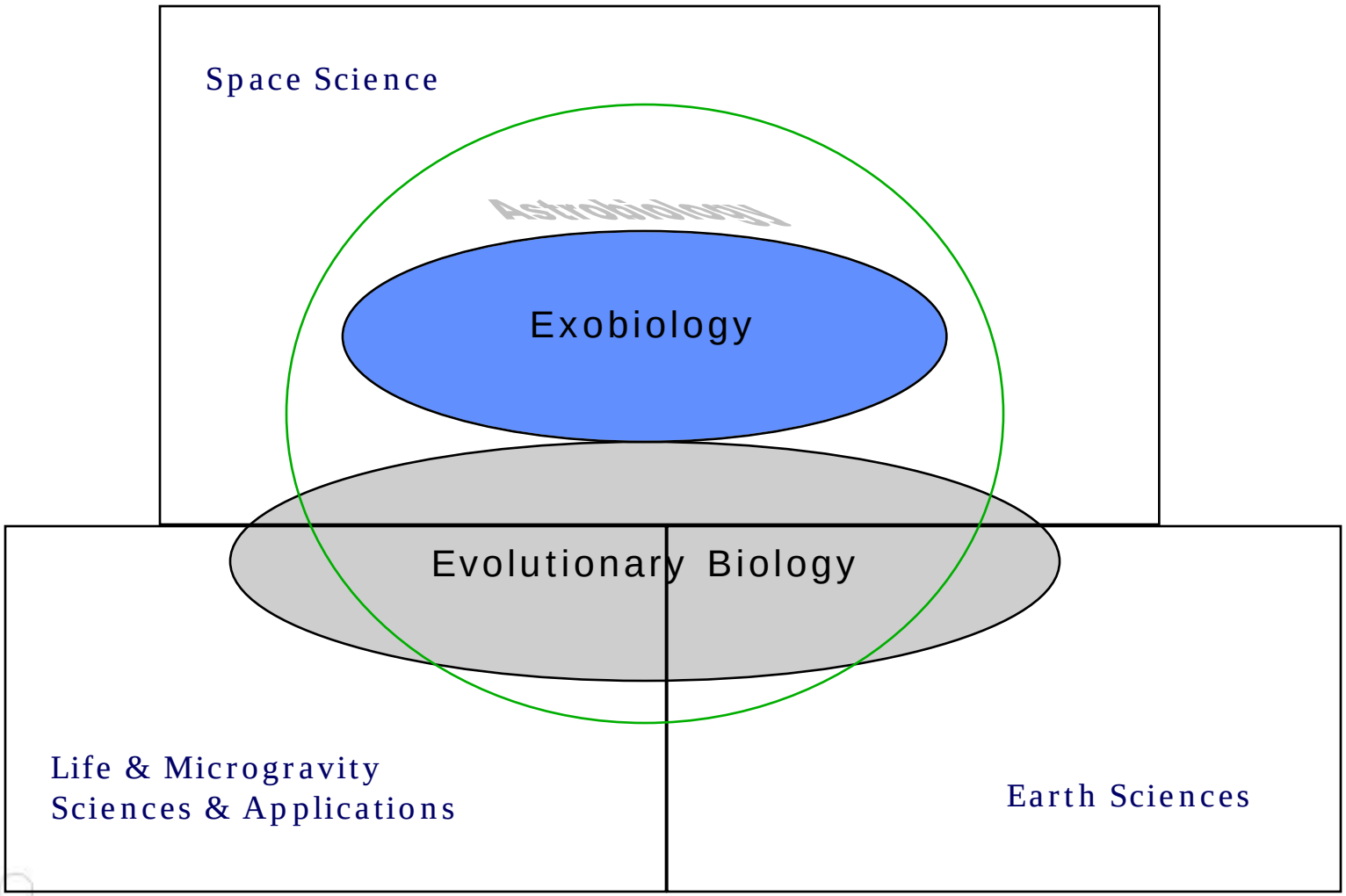
- Virtual institute “without walls” whose members conduct proposed interdisciplinary research and yet are geographically dispersed

Technology & Development

- Life-centered perspective in technology development and mission planning

Organizational Relations

ASTROBIOLOGY



Publications in Exobiology for 1998

ASTROBIOLOGY

- Nature
  - 2 papers
  - 3 comments

Williams DM; Kasting JF; Frakes LA
Low-latitude glaciation and rapid changes in the Earth's obliquity explained by obliquity-oblateness feedback, Nature. 1998 Dec 3;396(6710):453-5.
Irvine WM; Bergin EA; Dickens JE; Jewitt D; Lovell AJ; Matthews HE; Schloerb FP; Senay M
Chemical processing in the coma as the source of cometary HNC. Nature. 1998 Jun 11;393(6685):547-50

- Science
  - 2 feature articles
  - 4 papers
  - 2 comments

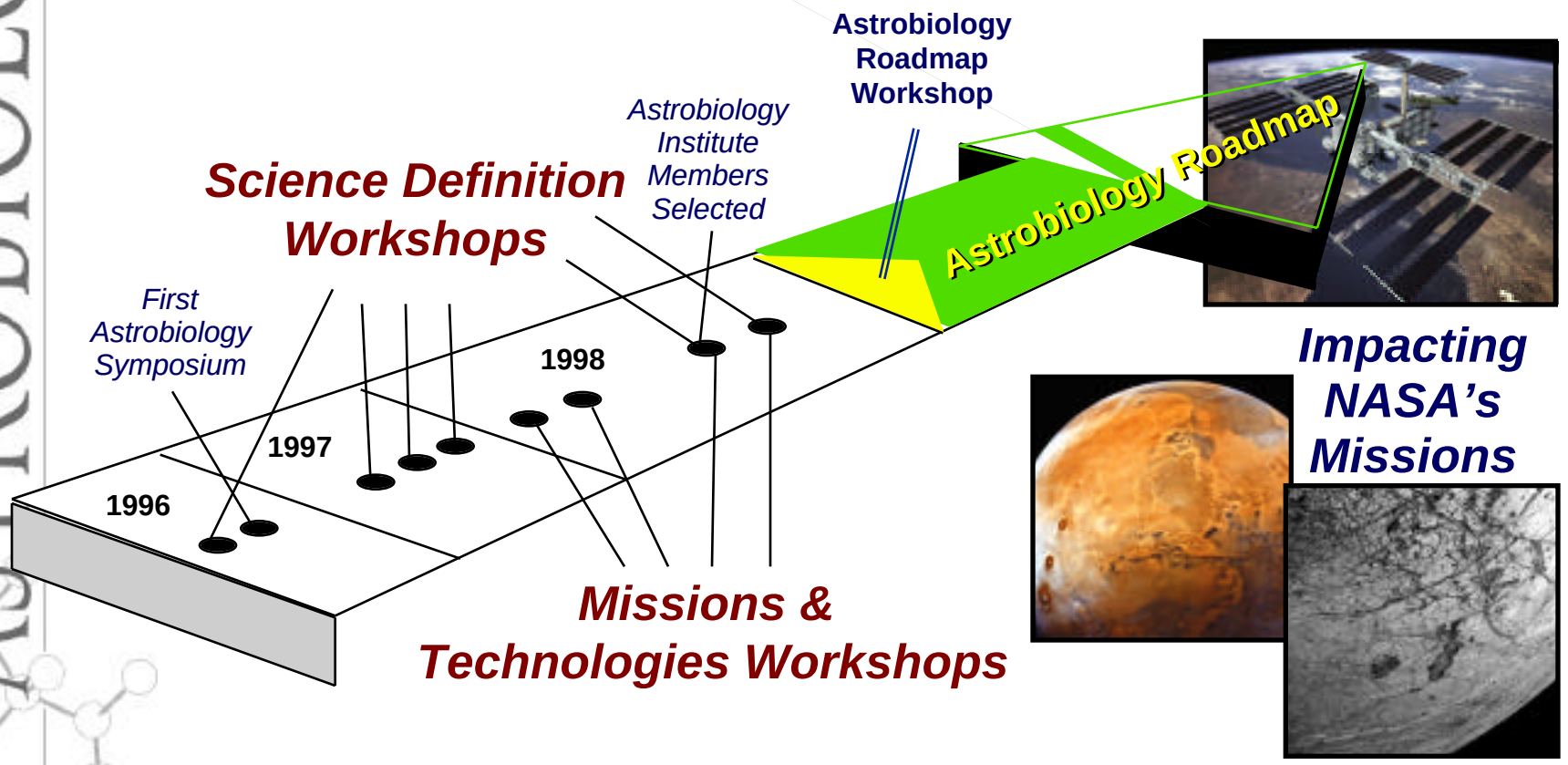
Amend JP; Shock EL
Energetics of amino acid synthesis in hydrothermal ecosystems. Science. 1998 Sep 11;281(5383):1659-62
Miller AI
Biotic transitions in global marine diversity. Science. 1998 Aug 21;281(5380):1157-60.
McKinney FK; Lidgard S; Sepkoski JJ Jr; Taylor PD
Decoupled temporal patterns of evolution and ecology in two post-Paleozoic clades. Science. 1998 Aug 7;281(5378):807-9
Brown RH; Cruikshank DP; Pendleton Y; Veeder GJ
Identification of water ice on the Centaur 1997 CU26. Science. 1998 May 29;280(5368):1430-2
Bowring SA; Erwin DH; Jin YG; Martin MW; Davidek K; Wang W
U/Pb zircon geochronology and tempo of the end-Permian mass extinction. Science. 1998 May 15;280(5366):1039-45
Bada JL; Glavin DP; McDonald GD; Becker L
A search for endogenous amino acids in martian meteorite ALH84001. Science. 1998 Jan 16;279(5349):362-5

- Proceedings of the National Academy of Sciences
  - 1 Review
  - 11 papers

Astrobiology Roadmap:

Charting a Path Towards the Future

350+ participants and 140+ workshop attendees from across the nation defined three Thematic Questions, ten Goals and 17 Objectives



How Does Life Begin and Evolve?

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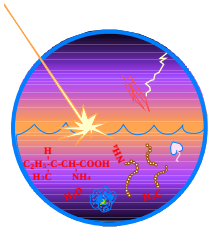
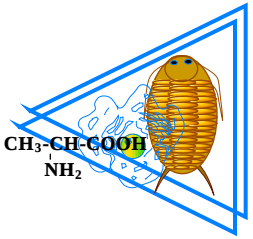
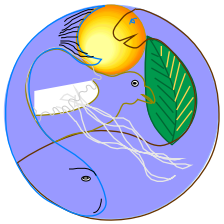


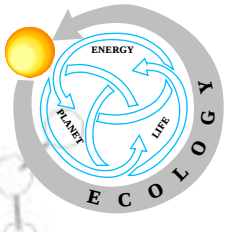
Understand how life arose on Earth



Determine the general principles governing the organization of matter into living systems



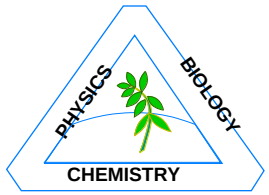
Explore how life evolves on the molecular, organism, and ecosystem levels



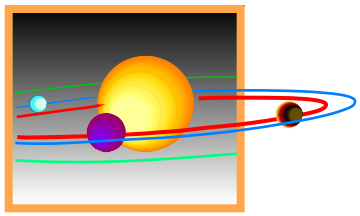
Determine how our planet's biosphere has co-evolved with Earth

Does Life Exist Elsewhere in the Universe?

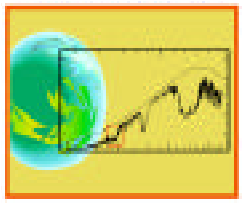
ASTROBIOLOGY



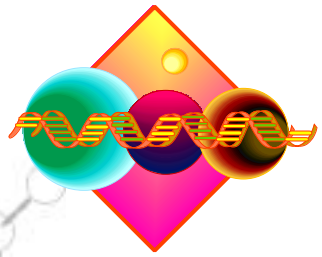
Establish limits for life in environments that provide analogues for conditions on other worlds



Determine what makes a planet habitable and how common these worlds are in the universe



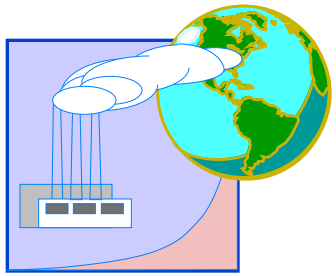
Determine how to recognize the signature of life on other worlds



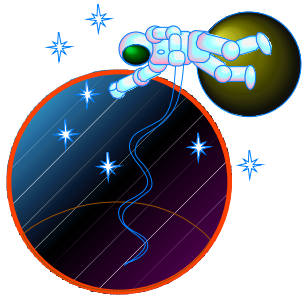
Determine whether there is (or once was) life elsewhere in our solar system, particularly on Mars and Europa

What Is the Future for Life on Earth and Beyond?

ASTROBIOLOGY



Determine how ecosystems respond to environmental change on time-scales relevant to human life on Earth



Understand the response of terrestrial life to conditions in space or on other planets

NASA Astrobiology Institute

- The Institute is an innovative experiment in multidisciplinary science and virtual collaboration
  - Worldwide excellence in multidisciplinary ground-based, laboratory research using modern information technology tools
  - Scientific leadership for NASA flight missions and research programs
  - Education and outreach

- Cooperative Agreement Notice (CAN) released Oct. 31, 1997
  - 53 proposals submitted
  - 11 member institutions selected on May 20, 1998

Science Research by PI's & Consortiums

ASTROBIOLOGY

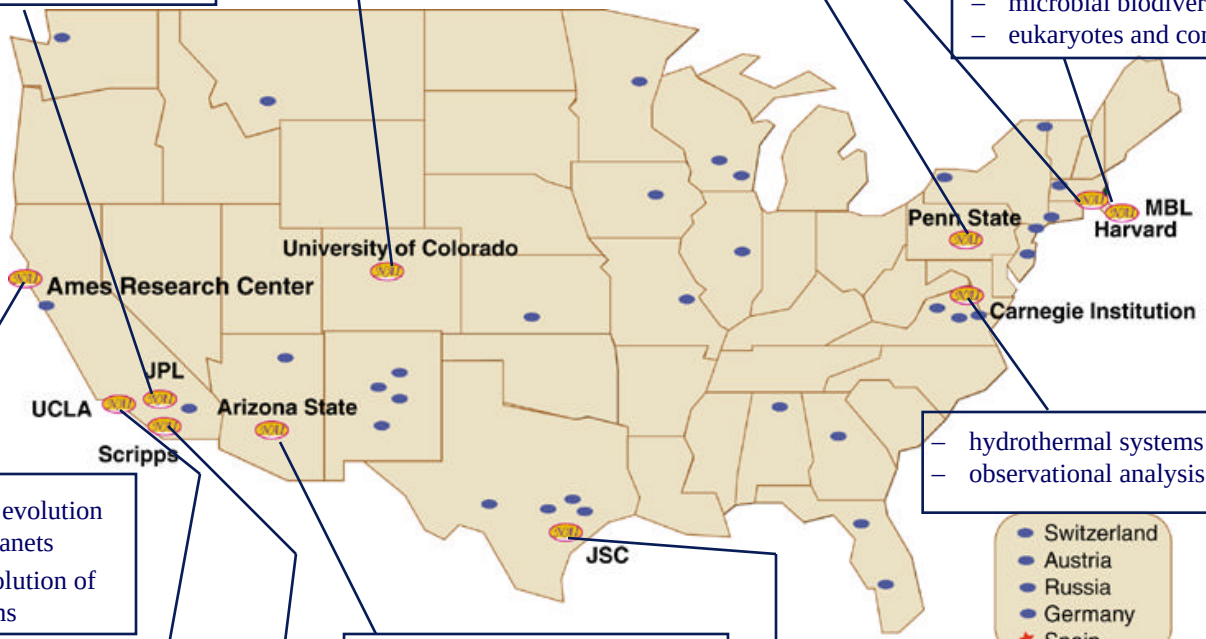
- origin of stars and planets
- habitable planets and the origins of life

- environmental changes and Earth's biota
- early stages of our planet's evolution

- co-evolution of Earth and its biota
- environmental transitions

- microbial biodiversity
- eukaryotes and complex systems

- credible biosignatures
- life in extraterrestrial samples



- hydrothermal systems
- observational analysis of Solar System

- formation and evolution of habitable planets
- Origin and evolution of microorganisms

- Earth's early life
- instrument development for detecting life

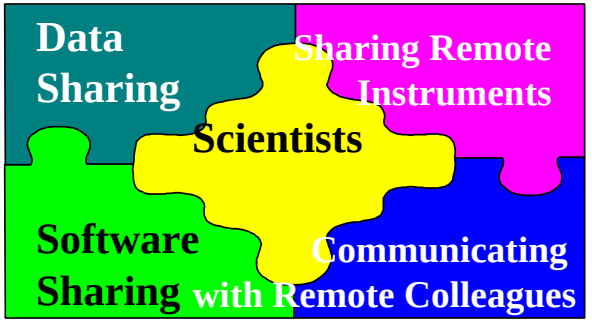
- extreme environments
- habitable environments

- emphasis on biomarkers
- analysis of meteorites and rocks

- self-replicating systems
- nature of pre-biotic worlds

- 11 Lead Institutions, 30 U.S. Consortium Members
10 International Consortium Members and 1 Associated Institute

Today's Virtual Collaboration:
The Challenge and the Solution

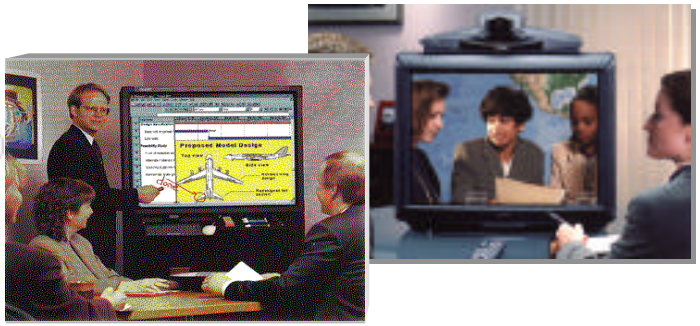


Challenge: Putting the puzzle together

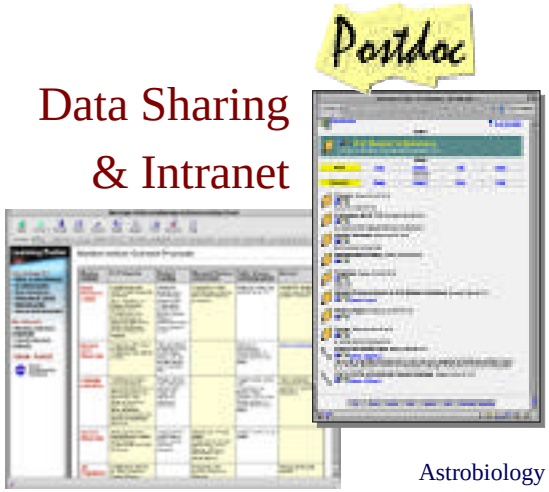
Solution: Group Video Conferencing & Desktop Collaboration

- Video conference equipment delivered and installed at lead institutions
- Electronic white boards will be installed by end of May
- Postdoc file-sharing software in place

Video & Data Conferencing



Data Sharing & Intranet



The Future of Virtual Collaboration

- Key elements in the Lab (examples)
  - Remote instrument access for telescopes, microscopes, etc.
  - Manipulation of chemical structures in a virtual model space by staff collaborating at a distance

- Support in the Field
  - Satellite sensor feeds from field to lab
  - Field videoconferencing
  - Tracking system for field samples

- Web broadcast services to the Desktop
  - Interactive web conferencing

Interim Management

- Interim Management Organization Established July 17, 1998
  - Scott Hubbard, et al assigned until permanent Director in place
- Interim Accomplishments: Establish the NASA Astrobiology Institute with sound managerial and technical foundations
  - Negotiate/fund/track Cooperative Agreements and MOAs
  - Assist ARC Center Director in recruiting permanent Director
  - Prepare NAI Implementation Plan and initiate NAI functions
  - Initiate application of Information Technology for virtual Institute
  - Establish basic elements of Education and Outreach
  - Hire/assign support staff and develop Institute Office

Administrative Status

ASTROBIOLOGY

- Director search status:
  - Nobel laureate candidate interviewed by Administrator Goldin 3/31
    - Agreement in principle reached

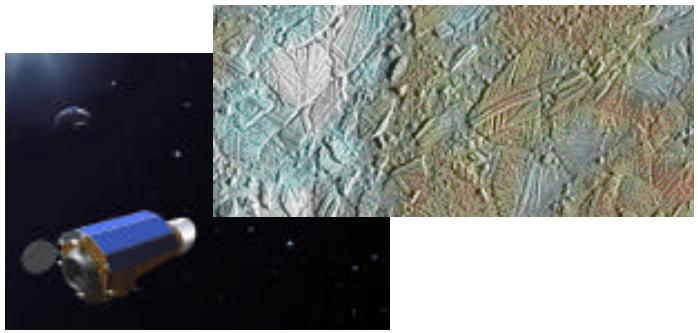
- Implementation Plan in Signature Process
  - Plan requirement to ARC in OSS letter dated 7/16/98
  - Reviewed by Hq Codes S, Y, U; ARC & SSAC
  - SSAC issues addressed and presented at 11/18/98 meeting
    - Independent NAI “Science Oversight Committee” defined
    - Administrative reporting through ARC science policy direction by Hq explained
  - Final approval by Headquarters 5/99

Next Cooperative Agreement Notice (CAN)

- Scientific content of next CAN to focus on mission elements
  - *Extrasolar biospheres*
  - *Genomics*
  - *Environmental process*
- Minority participation to be addressed
- International collaboration to be stimulated via Associated Institute mechanism
- Institute Director's Office will influence and lead the preparation and organization phase of the solicitation per NAI Implementation plan

Astrobiology Advanced Mission & Technology Status

- Technology studies initiated
  - Molecular-level computer modeling of protocellular systems
  - Microsensor for in situ investigations of the ecology of microbial communities
  - Biomodule to evaluate effects of extraterrestrial conditions of biological systems
  - Miniaturized technologies enabling material interactions between a model ecosystem and its harsh external environment
  - A light-weight device for large scale gene recognition
- Workshops identified technology focus areas
  - Sample management
  - Genomics
  - Computational Astrobiology
  - Life detection
  - Broad planetary surface access
  - Next generation of planet detection instruments



First Astrobiology Mission

- Leonids Mission 1998
  - Goal: Expand our knowledge of life's origins by studying cometary debris and its interactions with the Earth's atmosphere
- Leonid Multi-Instrument Aircraft Campaign '98 an outstanding success
  - Multiple-agency, cross-institution efforts worked flawlessly
- Results symposium held April 12-14 at ARC
  - High quality science data returned on meteors and persistent trains

Significant Recent Workshops

- Genomics on Space Station
  - Workshop held 27-29 January chaired by two Nobel laureates
    - Key conclusions:
      - Modern genomic tools and analysis allows a deep understanding of the adaptation of terrestrial life to novel environments
      - ISS excellent platform to obtain high quality astrobiology science

- Pale Blue Dot II
  - Workshop to be held May 19-21
    - Focus is on remote detection of life in other planetary systems
    - Brings together experts from a wide variety of science disciplines to
      - examine current state of understanding in the field,
      - lay out an approach & milestones to advance to the ultimate goal
      - investigate potential impacts on design of TPF, Darwin

Education & Public Outreach (Cont'd)

- A learning center
  - **THE** resource for astrobiology education by validating curriculum
    - Stanford University Astrobiology Course continued
    - Aerospace States Assoc. middle school astrobiology curriculum developed
    - TERC High School Web Curriculum co-funded by NSF and NASA underway
    - SETI Institute Astrobiology based high school curriculum "Voyages through Time" funded by NSF in collaboration with Astrobiology Institute
    - 2nd year of Astrobiology Academy completed, 3rd in preparation
  - Initiating a Postdoctoral Fellows Program

The Three Things You Should Take Away From This Presentation

- Astrobiology provides the scientific structure and direction for NASA's most exciting new thrust – ***"Are we alone in the Universe?"***
- Creating the **Astrobiology Roadmap** has established the goals and objectives of this new discipline
- Founding the **virtual NASA Astrobiology Institute** has initiated a new research community which is already productive

Implement the Roadmap

For more information about Astrobiology, visit our web sites:

http://astrobiology.arc.nasa.gov

http://nai.arc.nasa.gov